

**KAIST IP US LLC**

**v.**

**Samsung Electronics Co., LTD., et al.**

**Defendants' Rebuttal (Motion for JMOL on Non-Infringement (Dkt. 578))**

July 25, 2019

**“first oxide layer”**

# Dr. Subramanian Testified That the $\text{SiO}_2$ and $\text{HfO}$ Layers Are a Gate Oxide—Not a “gate oxide layer”

Dr. Subramanian



Defendants' Expert

Q. After refreshing your recollection, you would agree that the accused devices have **one gate oxide** which - which wraps around the surface?

A. Yes.

Q. **And that one gate oxide is Hafnium oxide and silicon dioxide, fair?**

A. **Yes, it has both of those layers in there.**

Q. Sir, let me reask the question. There's **one gate oxide?**

A. Yes, sir.

Q. Made up of Hafnium oxide and silicon dioxide, yes or no?

A. Yes, sir.

# Dr. Subramanian Was Precluded From Testifying That the SiO<sub>2</sub> and HfO Layers Are Not A Single Oxide Layer

Dr. Subramanian



Defendants' Expert

## *The Court*

THE COURT: It's clear from what happened in our discussion in chambers that the Hafnium oxide layer and the silicon dioxide layer together form a single oxide layer. And he's not going to say that both of them together are not the single oxide layer.

6/14 AM 21:7-11

## *Dr. Subramanian*

Q. In your report, you stated that the accused 14-nanometer devices have a single oxide layer made up of Hafnium oxide and silicon dioxide, fair?

A. I don't recall the exact words, but that sounds reasonable.

6/14 AM 84:18-22



# Defendants Have Applied The Plain and Ordinary Meaning of “formed on” Throughout This Litigation

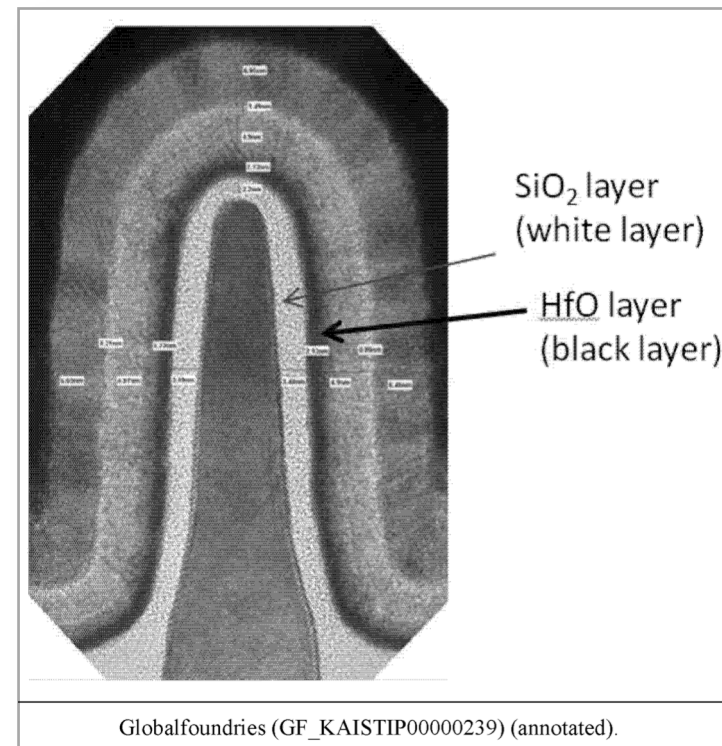
Dr. Subramanian



Defendants' Expert

¶ 112: “The interfacial  $\text{SiO}_2$  is formed at all locations on the surface of the parabolically-shaped fin at the same time using the same process. The interfacial  $\text{SiO}_2$  layer cannot correspond to the claimed ‘first oxide layer’ because the gate electrode is not **formed on** the interfacial  $\text{SiO}_2$  as required by the claims.”

¶ 113: “The  $\text{HfO}$  layer is not **formed on** the surface of the semiconductor fin. Instead, the  $\text{HfO}$  layer is **formed on** the surface of the interfacial  $\text{SiO}_2$  layer. As such, the  $\text{HfO}$  layer cannot correspond to the claimed ‘first oxide layer’ which is required to be **‘formed on** the upper surface of said Fin active region’.”



# Mr. Jeong Testimony Cited By Plaintiff

Mr. Jeong



Samsung Fact  
Witness


Q. There's a **gate oxide** that's **present on** both sides of the Fin, correct?

A. Yes, **gate oxide**. And the gate **wraps around** the Fin, all three sides of the Fin, so Fins under the gate -- and when we say the gate, we don't differentiate the sides or the bottom because the gates wrap around all three sides.


## Rebuttal:

- Testimony does not address “layer” or “formed on” claim requirements

## Defendants' Engineers Confirm Gate on Oxide



Dongwon Kim  
Technical VP



Q. So, there is an oxide layer that exists on both sides of the Fin and also wraps around the Fin, correct?

A. **In oxide, there's one continuous layer, and that one continuous layer of gate oxide wraps around all three sides of the fin.**

Dongwon Kim at 256:19-25

Q. And then there is a **gate which is formed on the oxide layer that exists on all three sides**, correct?

A. **Yes.**

Dongwon Kim at 257:22-25

PDX3.91

### Rebuttal:

- Testimony does not address “formed on the upper surface of said Fin” claim requirement

# Dr. Dongwon Kim Trial Testimony

Dr. Dongwon Kim



Samsung Fact  
Witness

Q. Now, Dr. Kim, the -- in the 14-nanometer devices, there is one continuous layer of oxide -- of gate oxide that **wraps around** all three sides of the fin, correct?

A. Yes, that is correct.

Q. And then there's a gate which is formed on the **oxide** that **exists** on all three sides, correct?

A. That is correct.

Q. **That gate oxide is a combination of silicon dioxide and Hafnium oxide, correct?**

A. **That is correct.**


- Testimony does not address “formed on the upper surface of said Fin” claim requirement




# Globalfoundries Witness, Dr. Samavedam, Testified That the SiO<sub>2</sub> and HfO Layers Are a Gate Oxide—Not a “gate oxide layer”

- Deposition testimony cited by Plaintiff:

**Combination of HfO and SiO<sub>2</sub> Make Up Gate**



**Srikanth Samavedam**  
Senior Engineer



Q. That layer is involved and what allows the gate to control current flow through the fin, correct?

A. *Combination of the hafnium dioxide layer and the SiO<sub>2</sub> interstitial layers that make up the gate.*

Samavedam 247:17-20

Dkt. 592-1 at PDX3.90

- Dr. Samavedam clarified this testimony at trial:

Q. It's the combination of the Hafnium dioxide layer and the silicon dioxide layer that make up the gate, correct?

A. When you say “gate,” you mean the gate dielectric?

Q. The gate oxide, sir.

A. Yes.

Q. And the combination of the Hafnium oxide and silicon dioxide is a gate oxide, correct?

A. Sure.

# Dr. Samavedam Trial Testimony Cited By Plaintiff

Dr. Samavedam



Globalfoundries  
Fact Witness

Q. ...The bottom portion of the gate oxide is formed on the Fin, correct?

A. Yes, that is correct.

Q. And the gate is formed on the top portion of the gate oxide, correct? The Hafnium dioxide?

A. The gate is formed on the Hafnium dioxide, correct, yes.

## Rebuttal:

- Testimony does not address “layer” claim requirements

# Dr. Wallace Testified That Two Layers Are In Between the Accused Fin and Gate

## Cross-exam

Q. And so there is this gate oxide layer and on top of it is formed a gate, correct?

A. That's correct.

Q. And that gate oxide layer is formed on the Fin, correct?

A. That's correct.

6/13 PM 196:24-197:3

## Redirect

Q. Okay. So counsel just asked you about a so-called gate oxide layer. Let's be clear, there's -- tell me how many layers are in between the Fin and the gate?

A. There's two.

. . .

Q. (By Mr. Soobert) What are those two layers?

A. There's a layer of silicon oxide and a layer of Hafnium oxide.

Q. Okay. Which one of those layers is formed on the Fin?

A. The silicon oxide is the layer formed on the Fin surface.

Q. Okay. And which one of those layers is the gate formed on?

A. The gate -- the metal gate is formed on the Hafnium oxide layer.

6/13 PM 197:16-19, 198:2-15<sub>11</sub>

Dr. Wallace



Defendants'  
Oxidation Expert

# Undisputed That the SiO<sub>2</sub> and HfO Layers Are Two Separate Layers

Dr. Kuhn



Plaintiff's Expert

Q. Okay. But there's no question that you have described that gate oxide as a bilayer, right?

A. Historically.

Q. Yes?

A. Yes, sir.

Q. It is a bilayer, right, it's two layers?

A. It is fabricated as two layers, you can describe it as a bilayer, yes, sir.

Q. All right. It is -- it's certainly two separate layers separate processes, separate properties, separate times and --

A. I -- I agree with that, sir.

Q. All right. That's just undisputed?

A. I agree with that, sir.



# Dr. Samavedam Confirmed the HfO Layer is Not Formed On the Surface of the Fin

Dr. Samavedam



Globalfoundries  
Fact Witness

Q. Is the Hafnium oxide formed on the surface of the Fin?

A. The Hafnium oxide is formed on the silicon oxide layer.

Q. So let me ask that again. Is the Hafnium oxide layer formed on the surface of the Fin?

A. No.

# As Dr. Kuhn Conceded, Even Changing Just One Device Feature Causes a Ripple Effect of Changes To the Device

Dr. Kuhn



Plaintiff's Expert

- Q. Dr. Kuhn, in the 2000 -- early 2000 time period, how predictable was nano-scale transistor design?
- A. Nano-scale transistor design has never been predictable. There's a number of effects that occur. For example, there's a ripple effect where you change something, and it changes something else, which changes something else. And pretty soon you have the whole front end down. If you change a single contact, then you have to change the etch that goes with it, then you have to change the material that goes with the etch, and then that wrecks your spacers, and then have to change the implant. And it just goes on and on and on.

Recall the time you tried to just put a patio in the yard and ended up redoing the entire yard. Same problem.

# Dr. Kuhn Conceded That “the device does not work” If Either the SiO<sub>2</sub> Layer or HfO Layer Is Removed

Dr. Kuhn



Plaintiff's Expert

Q. One last question, Dr. Kuhn, on the left you're describing those components as the gate oxide?

A. Yes, sir, these components.

Q. Is that one layer?

A. It's a layer with two components. It acts like a gate oxide, a single gate oxide. And I think overall in this trial, we've all reached agreement that if you remove either layer, the device does not work.

**“formed on”**

# Magistrate Judge Payne Denied Plaintiff's Summary Judgment Because "Formed On" Does Not Permit An Intervening Layer

This presents a fact issue for the jury to resolve—whether the SiO<sub>2</sub> and HfO layers are a single layer formed on the sidewalls and upper surface of the fin active region. The answer to *that* question, in turn, relates to whether the gate is formed on the “first oxide layer” as recited by the claims. Thus, because Defendants have presented evidence from which a jury might return a verdict in their favor, Plaintiff's Motion for Summary Judgment of Infringement [Dkt. # 228] should be **DENIED**.

# Magistrate Payne's Ruling In Light of Whether HfO and SiO<sub>2</sub> Are Two Layers (Defendants' Position) or a Single Layer (Plaintiff's Position)

Defendants present evidence that the accused devices have a silicon dioxide layer (SiO<sub>2</sub>) formed around the entire surface of the fin. Subramanian Rep. [Dkt. # 228-10] ¶ 110. “Well after” formation of that SiO<sub>2</sub> layer, a different process forms a hafnium dioxide (HfO) layer over the SiO<sub>2</sub> layer. *Id.* ¶ 111. The gate electrode is then formed on the HfO layer. *Id.* ¶ 121. *See* GF\_KAISTIP00000239 *supra*.

Plaintiff contends the SiO<sub>2</sub> and HfO layers together compose a broader layer formed completely around the fin. Pl.’s Mot. [Dkt. # 228] at 14. The SiO<sub>2</sub> part of this broader layer

...

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# Defendants Have Applied the Plain and Ordinary Meaning of “formed on” Throughout This Litigation

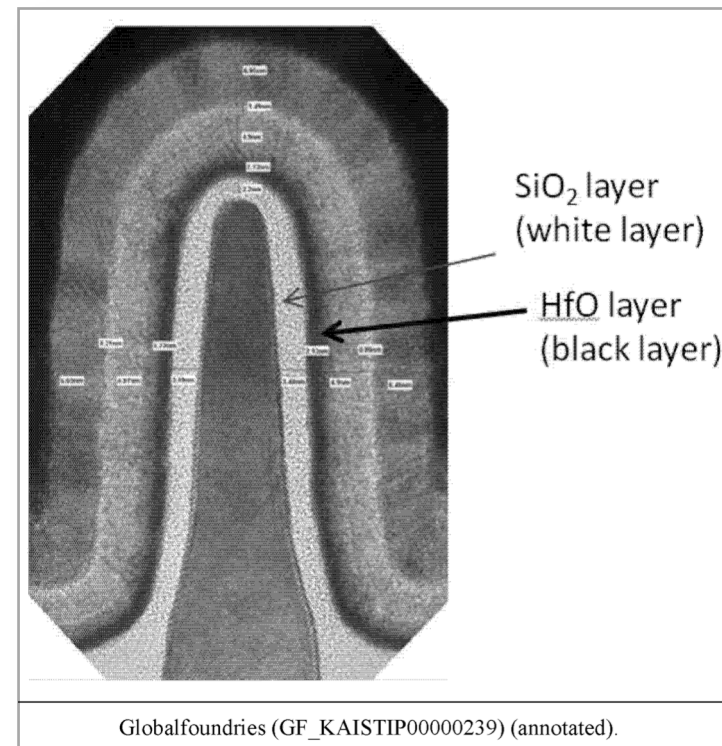
Dr. Subramanian



Defendants' Expert

¶ 112: “The interfacial  $\text{SiO}_2$  is formed at all locations on the surface of the parabolically-shaped fin at the same time using the same process. The interfacial  $\text{SiO}_2$  layer cannot correspond to the claimed ‘first oxide layer’ because the gate electrode is not formed on the interfacial  $\text{SiO}_2$  as required by the claims.”

¶ 113: “The  $\text{HfO}$  layer is not formed on the surface of the semiconductor fin. Instead, the  $\text{HfO}$  layer is formed on the surface of the interfacial  $\text{SiO}_2$  layer. As such, the  $\text{HfO}$  layer cannot correspond to the claimed ‘first oxide layer’ which is required to be ‘formed on the upper surface of said Fin active region’.”



# The SiO<sub>2</sub> and HfO Layers Are Formed by Different Processes

Dr. Kuhn



Plaintiff's Expert

Q. Now, the Defendants' products, these two layers, Hafnium oxide, which is formed on the silicon dioxide layer, are formed by different processes, aren't they?

A. Yes, sir.

...

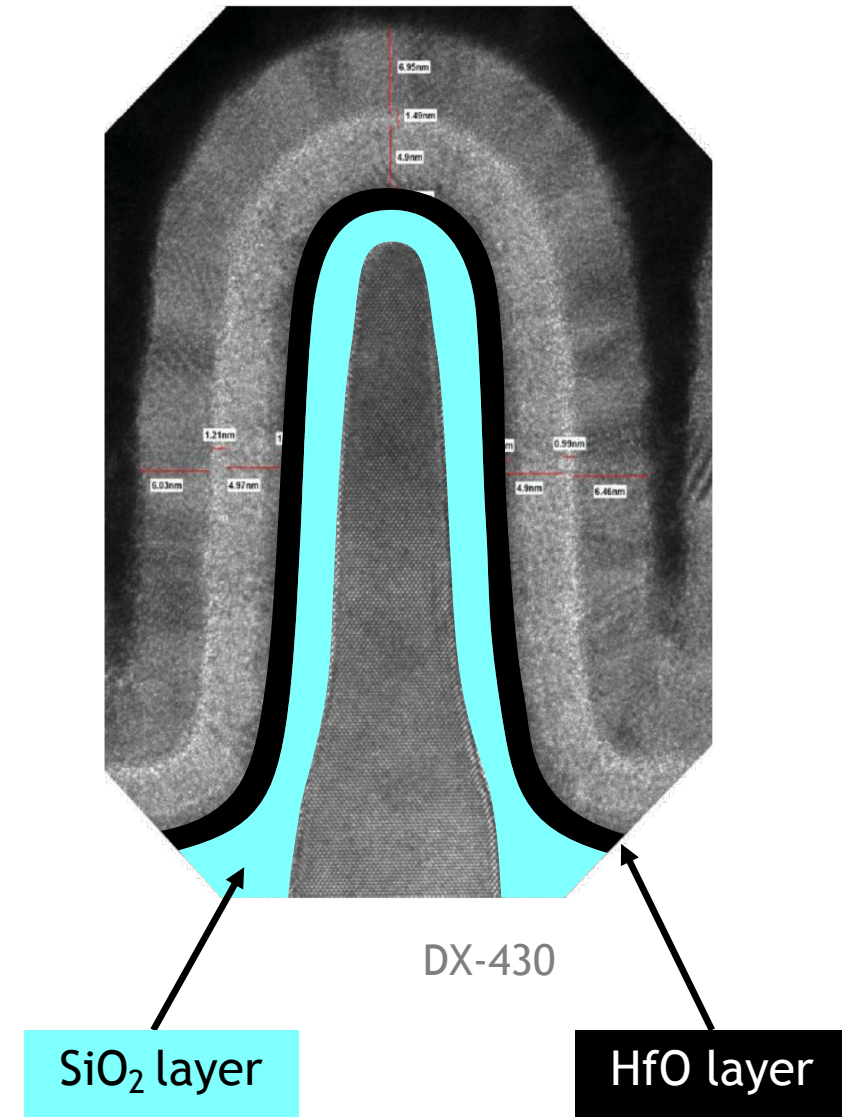
Q. So with that clarification, you agree that the lighter-colored silicon dioxide layer is formed through a process of oxidation, right?

A. Yes, sir.

...

Q. The Hafnium oxide layer in this process is formed actually by what's known as atomic layer deposition. You agree?

A. That's my understanding, sir.





# The SiO<sub>2</sub> and HfO Layers Are Formed by Different Processes

Dr. Samavedam



Globalfoundries  
Fact Witness

Q. (By Mr. Soobert) Now, are those the same materials, silicon dioxide and Hafnium oxide?

A. No, they're not. They're different materials.

Q. Okay. How are they formed?

A. The silicon oxide is formed by oxidation process. So what I mean by oxidation is when you take this -- when you take the silicon Fin and expose it to a chemical or a gas containing oxygen, it forms an oxide. And so you can form an oxide on the -- using the thermal process where you heat up the -- heat up the silicon Fin and expose it to a hard gas, or you can form it using a chemical oxidation where you clean the -- the Fin with -- with water containing - oxygen containing chemical. So that's how the -- the silicon oxide is formed. And the Hafnium oxide is formed using a technique called ALD, atomic layer deposition. So you literally deposit atom by atom. So it's a completely different technique of forming the Hafnium oxide than the silicon oxide.

# Plaintiff's Belated Construction That "formed on" Permits an Intervening Layer Should Be Rejected

- Plaintiff waived its construction by not raising it.
- Plaintiff's new construction is not supported by the '055 Patent, which does not mention or suggest intervening layers.

[T]he present invention comprises... a first oxide layer 6 which is **formed on** the upper surface of the Fin active region 4..., a gate 16 which is **formed on** the first oxide layer 6 and second oxide layer 10...

'055 Patent at 5:35-47

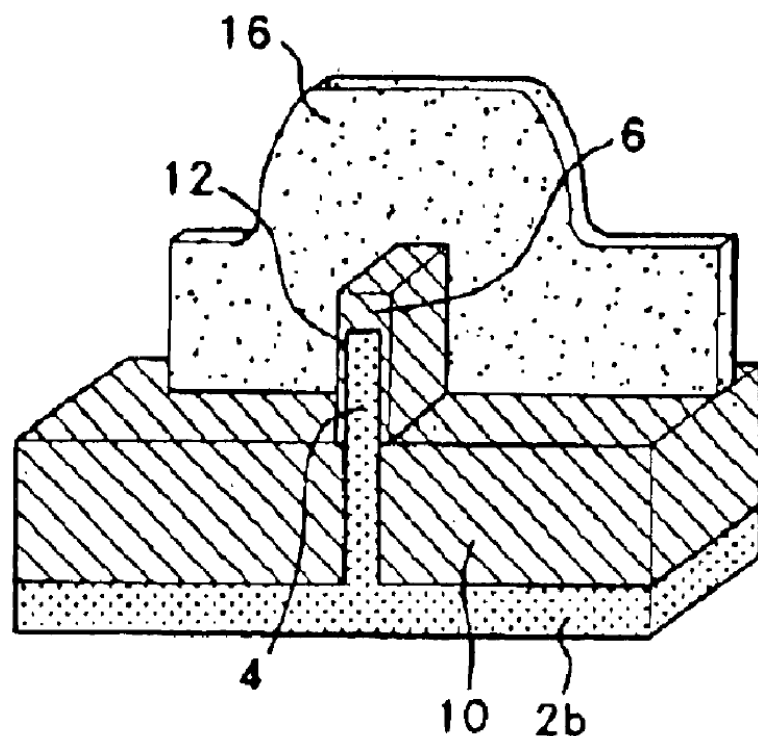


Fig. 3b

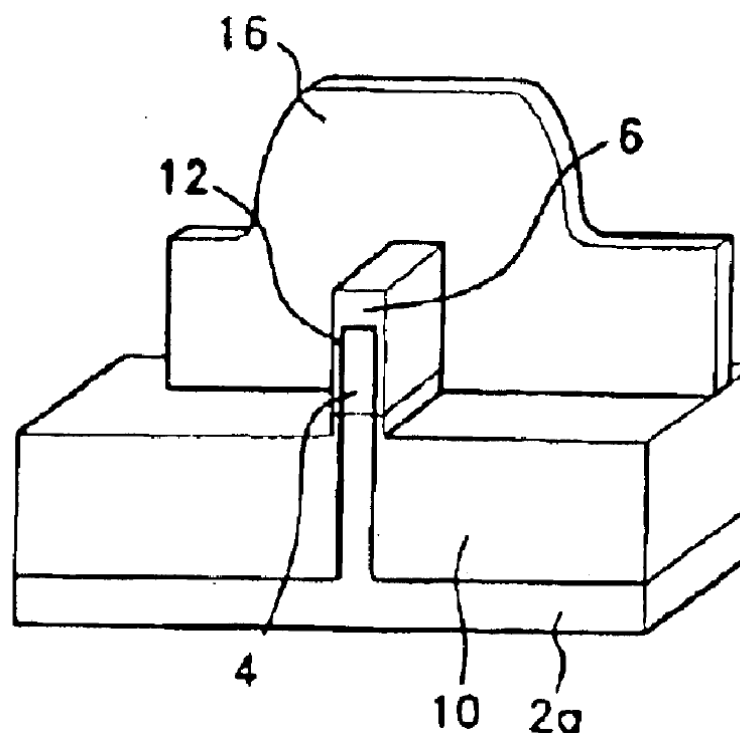


Fig. 4a

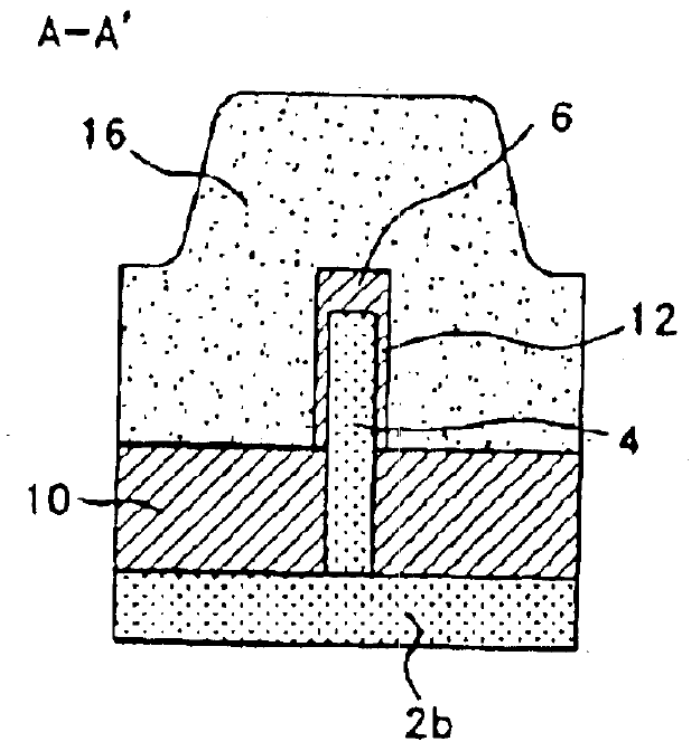


Fig. 7

# Plaintiff's Belated Construction Is Not Supported By the '055 Patent and Should Be Rejected



“A party is, therefore, not entitled to a claim construction divorced from the context of the written description and prosecution history.”

*Eon Corp. IP Holdings v. Silver Spring Networks*, 815 F.3d 1314, 1320 (Fed. Cir. 2016)



“The only meaning that matters in claim construction is the meaning in the context of the patent.”

*Eon Corp. IP Holdings*, 815 F.3d at 1321

# Plaintiff's Belated Construction Is Not Supported By the '055 Patent



Where “[t]he claims themselves are silent as to whether ‘form[ing/ed] on’ permits intervening layers”

and

“[n]othing in the specification mentions intervening layers or suggests that the inventors contemplated that intervening layers could be introduced....

[t]his is consistent with a meaning of ‘formed’ which does not permit intervening layers.”

*Nitride Semiconductors Co. v. RayVio Corp.*, 2018 WL 2183270, at \*5-6 (N.D. Cal. May 11, 2018)

**“first oxide layer ... thickness greater or equal to that of the gate oxide”**

# Samsung Fact Witness, Mr. Jeong, Testified the HfO Layer—Not the Stack of SiO<sub>2</sub> and HfO Layers— Had a “generally equivalent” Thickness

- Samsung Fact Witness Mr. Jeong:

Q. The **oxide below the gate** on all three sides of the Fin in Samsung's 40 -- 14-nanometer process is generally equivalent in thickness, correct?

A. They are equivalent.

6/13/18 AM at 47:17-20 (repeating Jeong deposition transcript of 15:6-11)

- Dr. Subramanian confirmed Mr. Jeong's testimony as referring to the Hafnium oxide layer:

MR. SOOBERT: Let's go to Mr. Heedon Jeong's deposition transcript, Page 15, Lines 6 through 11.

Q. (By Mr. Soobert) Counsel for Plaintiff showed you this language?

A. Yes, he did.

Q. You're familiar with his deposition?

A. Yes, sir.

Q. What's your understanding that's being said here?

A. Well, this is referring to the oxide below the gate. So in this context, **the oxide below the gate we know to be the Hafnium.**

6/14/18 PM at 42:14-24



# Dr. Samavedam Confirmed the HfO Layer—Not the Stack of SiO<sub>2</sub> and HfO Layers— Has an “equal” Thickness

Dr. Samavedam



Globalfoundries  
Fact Witness

Q. And the Hafnium dioxide layer is of equal thickness on all sides of the Fin, correct?

A. Yes.

Q. But there may be slightly manufacturing differences due to variance in manufacturing, correct?

A. Yes.

# Dr. Samavedam Confirmed the SiO<sub>2</sub> Layer Does Not Have “equal” Thickness

Dr. Samavedam



Globalfoundries  
Fact Witness

- Q. So can you -- can you comment a little further about the thicknesses of these layers?
- A. Yes. So one other difference that I noticed, you know, in our structures as compared to the -- compared to the '055 patent is that the -- the silicon oxide thickness, you know, on top of the Fin is -- is thinner than the silicon oxide on the side-walls of the Fin. And this is true for both the logic device that -- that is shown here. And if you go back one page, it is also true on the I/O device, you know.



# Mr. Jeong Testimony Cited By Plaintiff

Mr. Jeong



Samsung Fact  
Witness

Q: Would you explain whether there are any differences between the gate oxide layer that resides along the side walls and along top of the Fin?

A: There is no difference on the gate oxide on the sides and the gate oxide on the top.

## Rebuttal:

- Testimony just confirms that the oxide on the Fin side walls and along the Fin top is the same but does not address “thickness”

# Mr. Jeong Was Responsible For the Fin Definition Module Only—Not the Gate Oxide Module Or Any Other Module Of Accused 14 nm Process

Mr. Jeong



Samsung Fact  
Witness

Q: So as between you and Master Dong-won Kim, who would you say has more knowledge and better understanding of the technical issues we've discussed today?

A: Master Kim Dong-won was the one who supervised and oversaw the overall work. So he knows it better than myself.

Q: And why do you say that?

A: I was only responsible for one module, and Master Kim oversaw the overall 14-nanometer process, so overall, he knows better than myself.

. . .

Q: You were responsible for the integration of the modules relating to the definition of the Fin, correct?

A: Correct.

# Dr. Kuhn DOE Testimony Merely Addressed the Insulating Property of Oxides In General Instead of the Relative “thickness” Limitation at Issue

Dr. Kuhn



Plaintiff's Expert

- Q. So even with manufacturing variation then is this limitation met under the, for example, Doctrine of Equivalents?
- A. Yes, it would be. And under the Doctrine of Equivalents, the differences in the oxide layer thicknesses are insubstantial. I might point out if they were substantial, Samsung would have problems with its devices. But they're insubstantial, they have substantially -- excuse me -- the same function, and preventing short circuiting between the Fin active region and the gate in substantially the same way by using a thin layer of insulating oxide material that does not conduct charge carriers to provide the same result in preventing the flow of charge carriers between the Fin active region and gate.

# No Reasonable Jury Could Have Found the Claims Infringed Under DOE



“A plaintiff must provide particularized testimony and linking argument to show the equivalents are insubstantially different. Generalized testimony as to the overall similarity between the claims and the accused infringer's product or process will not suffice.”

*Gemalto S.A. v. HTC Corp.*, 754 F.3d 1364, 1374 (Fed. Cir. 2014)  
(internal citations and quotations omitted)